US007299863B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.:** **US 7,299,863 B2**
(45) **Date of Patent:** **Nov. 27, 2007**

(54) **LOUVER FIN TYPE HEAT EXCHANGER HAVING IMPROVED HEAT EXCHANGE EFFICIENCY BY CONTROLLING WATER BLOCKAGE**

(75) Inventors: **Dae-Young Lee**, Seoul (KR); **Hyun-Seon Choo**, Jeollanam-Do (KR)

(73) Assignee: **Korea Institute of Science and Technology** (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **11/311,498**

(22) Filed: **Dec. 19, 2005**

(65) **Prior Publication Data**

US 2006/0283581 A1 Dec. 21, 2006

(30) **Foreign Application Priority Data**

Jun. 17, 2005 (KR) 10-2005-0052629

(51) **Int. Cl.**
F28D 1/03 (2006.01)

(52) **U.S. Cl.** **165/152**; 165/166; 165/913

(58) **Field of Classification Search** .... 165/152, 165/166, 70, DIG. 197, DIG. 185, 913
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,580,624 A * 4/1986 Ishida et al. 165/152
4,756,362 A * 7/1988 Kudoh et al. 165/151
5,787,972 A * 8/1998 Beamer et al. 165/152
2002/0195235 A1* 12/2002 Falta et al. 165/152
2004/0031595 A1* 2/2004 Iwasaki et al. 165/135
2004/0050531 A1* 3/2004 Horiuchi et al. 165/41
2004/0069457 A1* 4/2004 Park et al. 165/104.21
2005/0006063 A1* 1/2005 Zhang 165/152

* cited by examiner

Primary Examiner—Teresa J. Walberg
(74) *Attorney, Agent, or Firm*—Ostrolenk, Faber, Gerb & Soffen, LLP

(57) **ABSTRACT**

Disclosed is a louver fin type heat exchanger positioned upright at a certain angle with respect to the ground, wherein lower end portions of louver fins close to the ground are bent toward lower end portions of adjacent louver fins, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at other portions thereof. Accordingly, moisture congregates only at a portion where the cross-section of the air passage is great, so that the external air smoothly passes into or out the heat exchanger through the air passage where the moisture congregation does not occur, minimizing the pressure drop, and efficiency in heat exchange of the heat exchanger can be thusly improved.

19 Claims, 7 Drawing Sheets

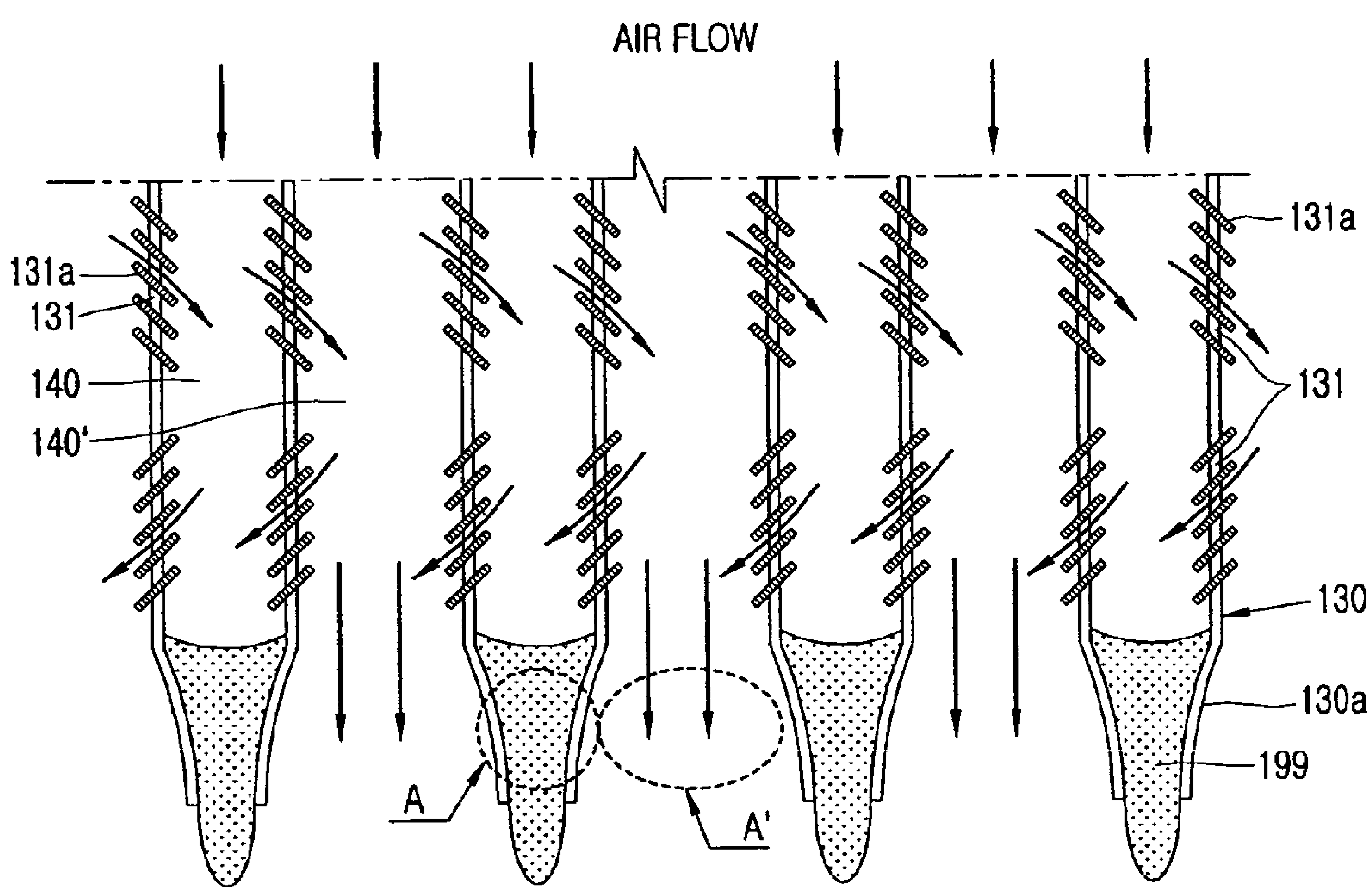


FIG. 1

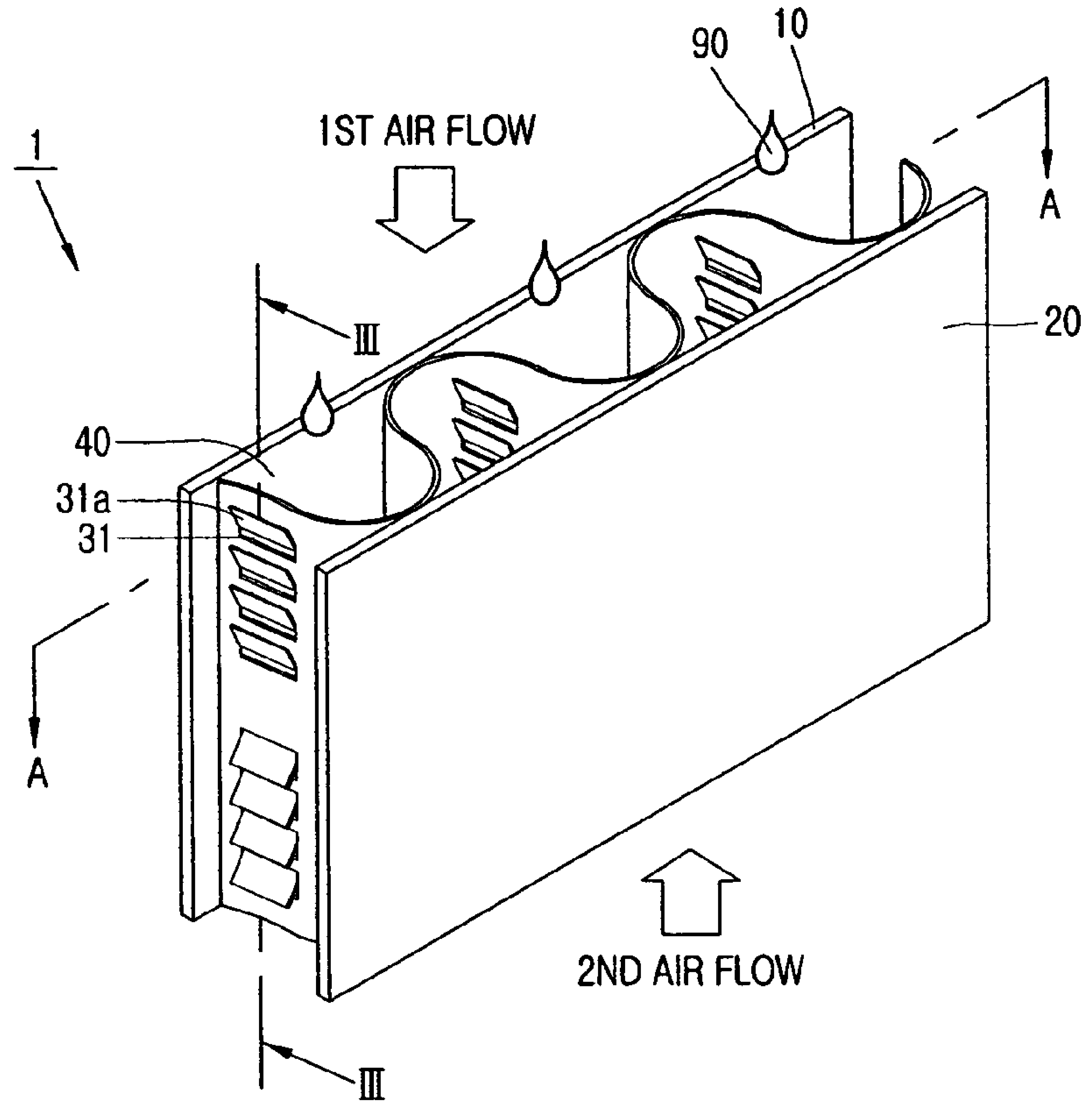


FIG. 2

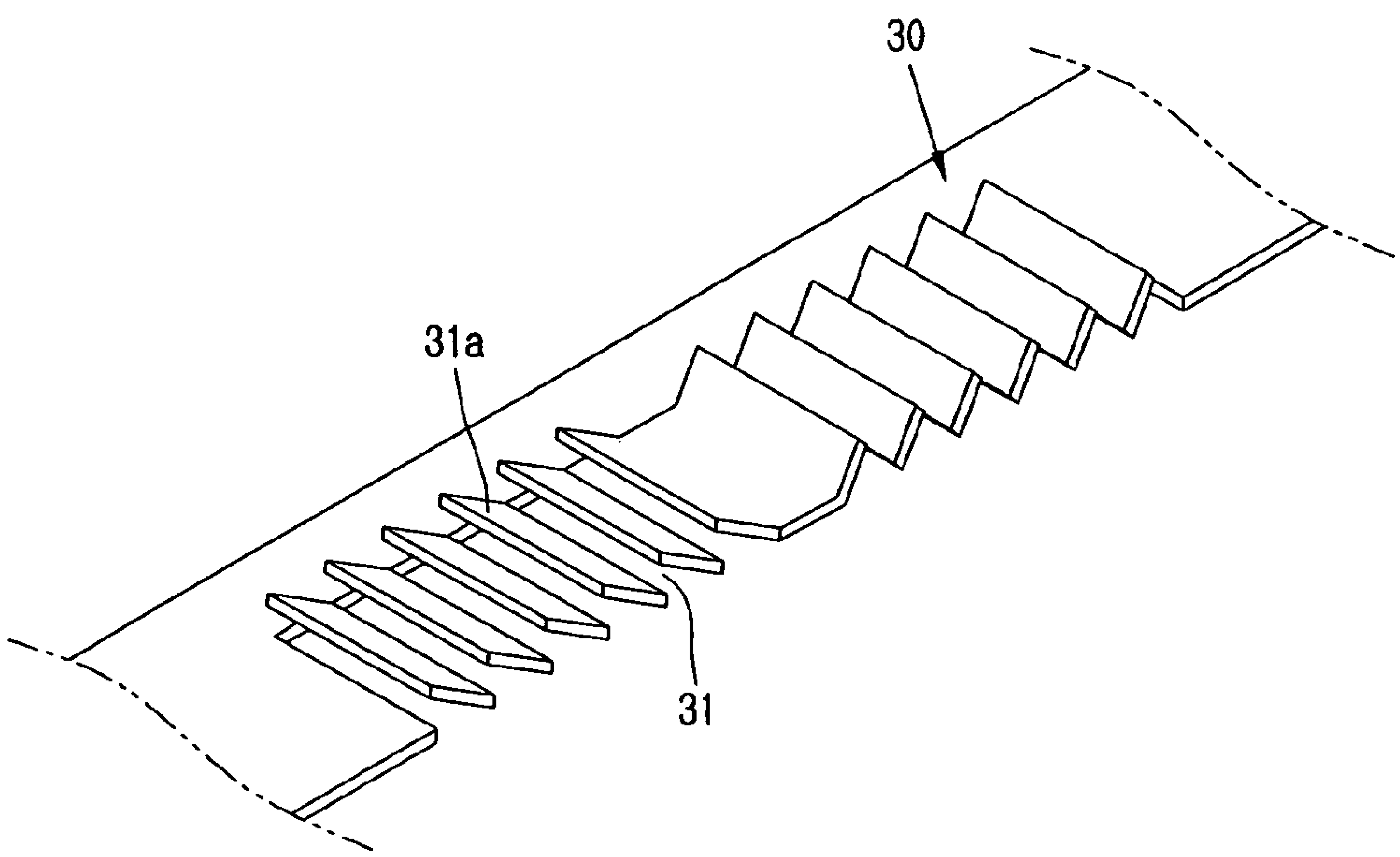


FIG. 3

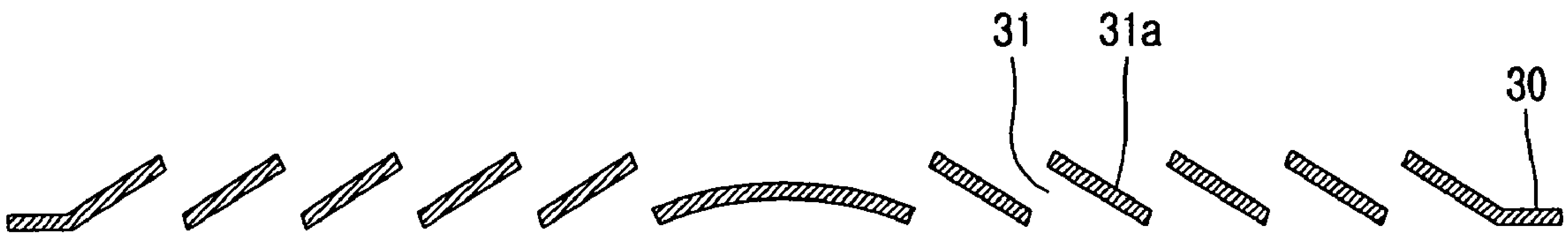


FIG. 4

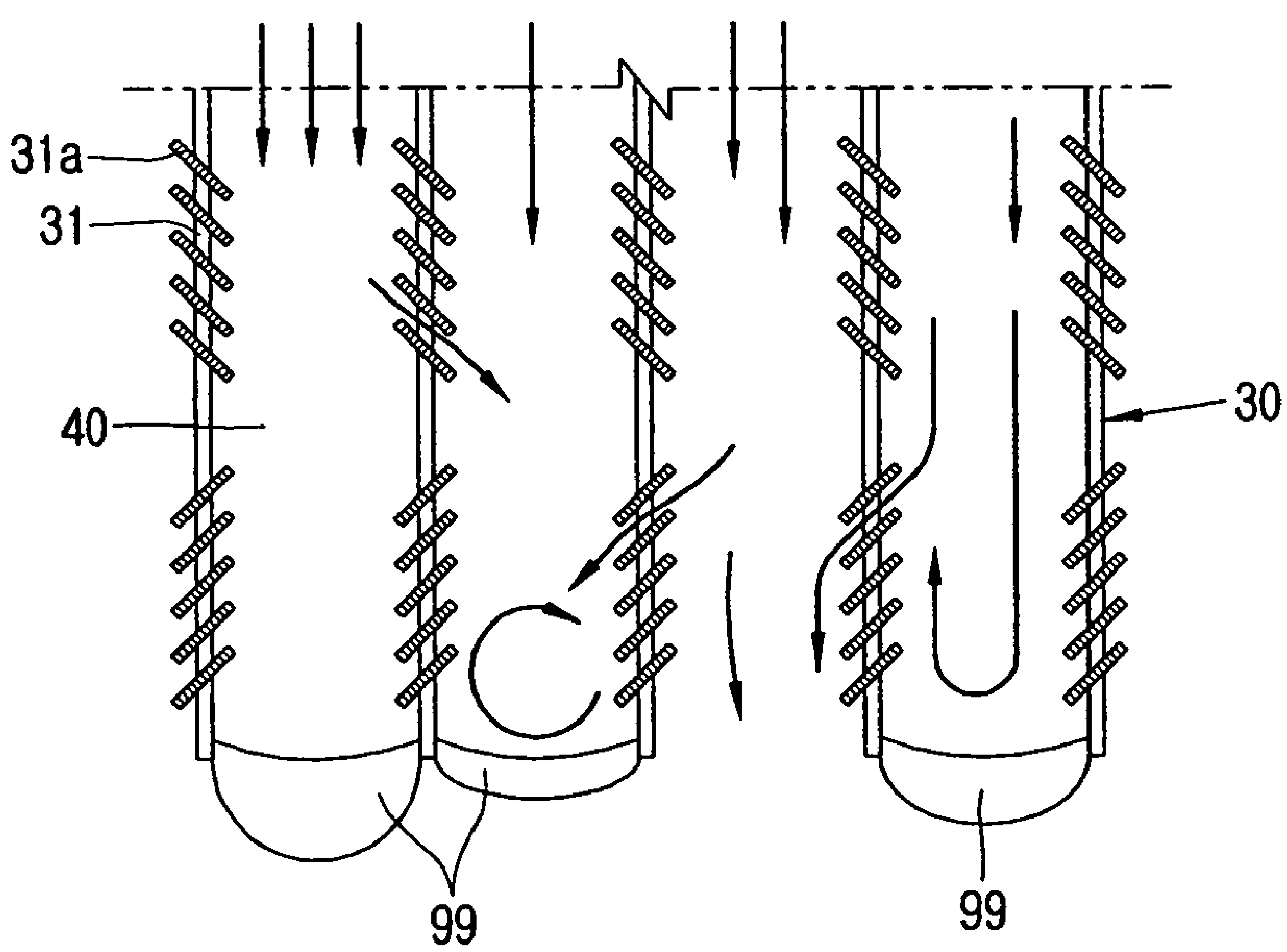


FIG. 5

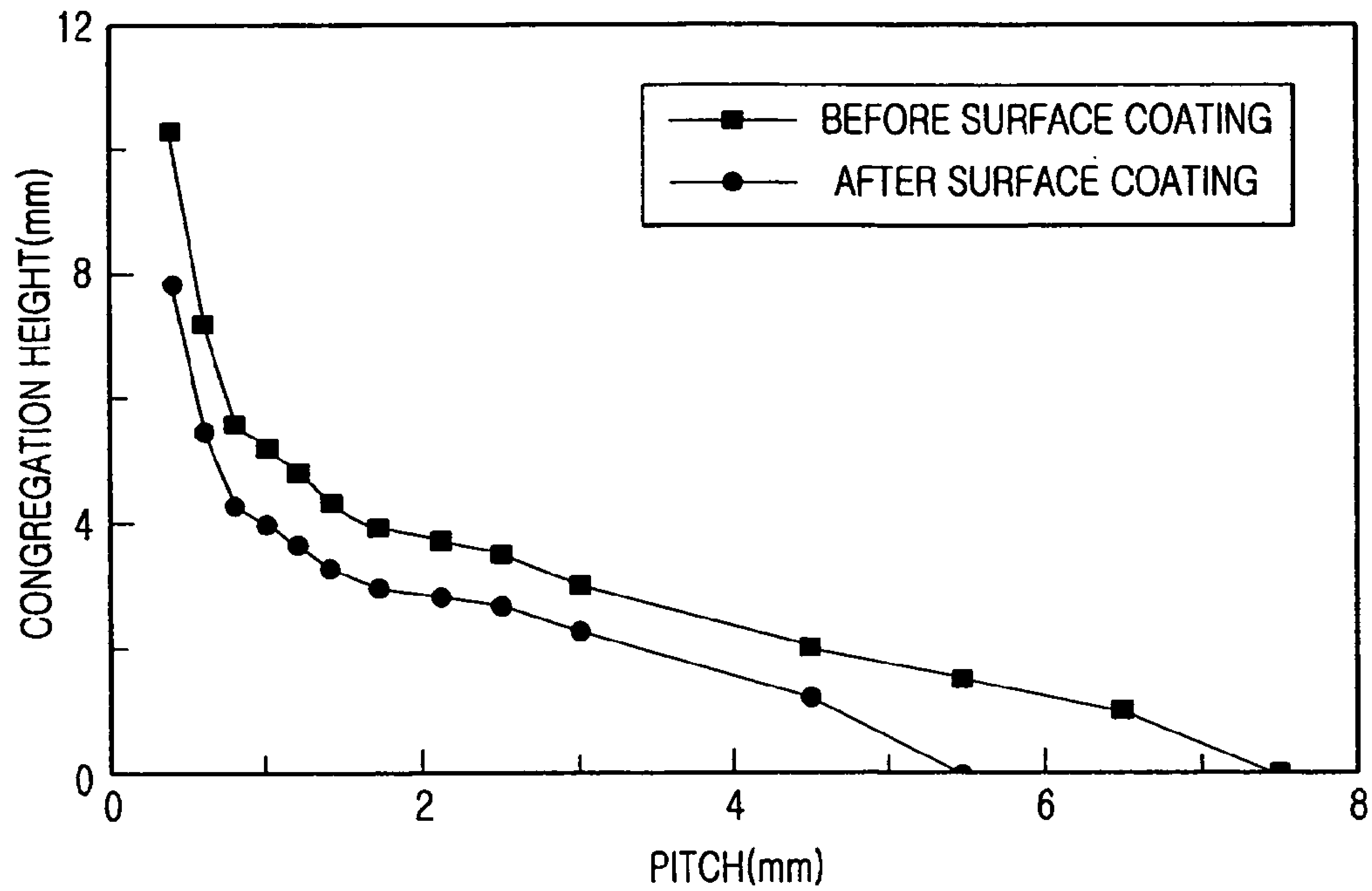

12
8
4
0
0
2
4
6
8
CONGREGATION HEIGHT(mm)
PITCH(mm)
BEFORE SURFACE COATING
AFTER SURFACE COATING

FIG. 6

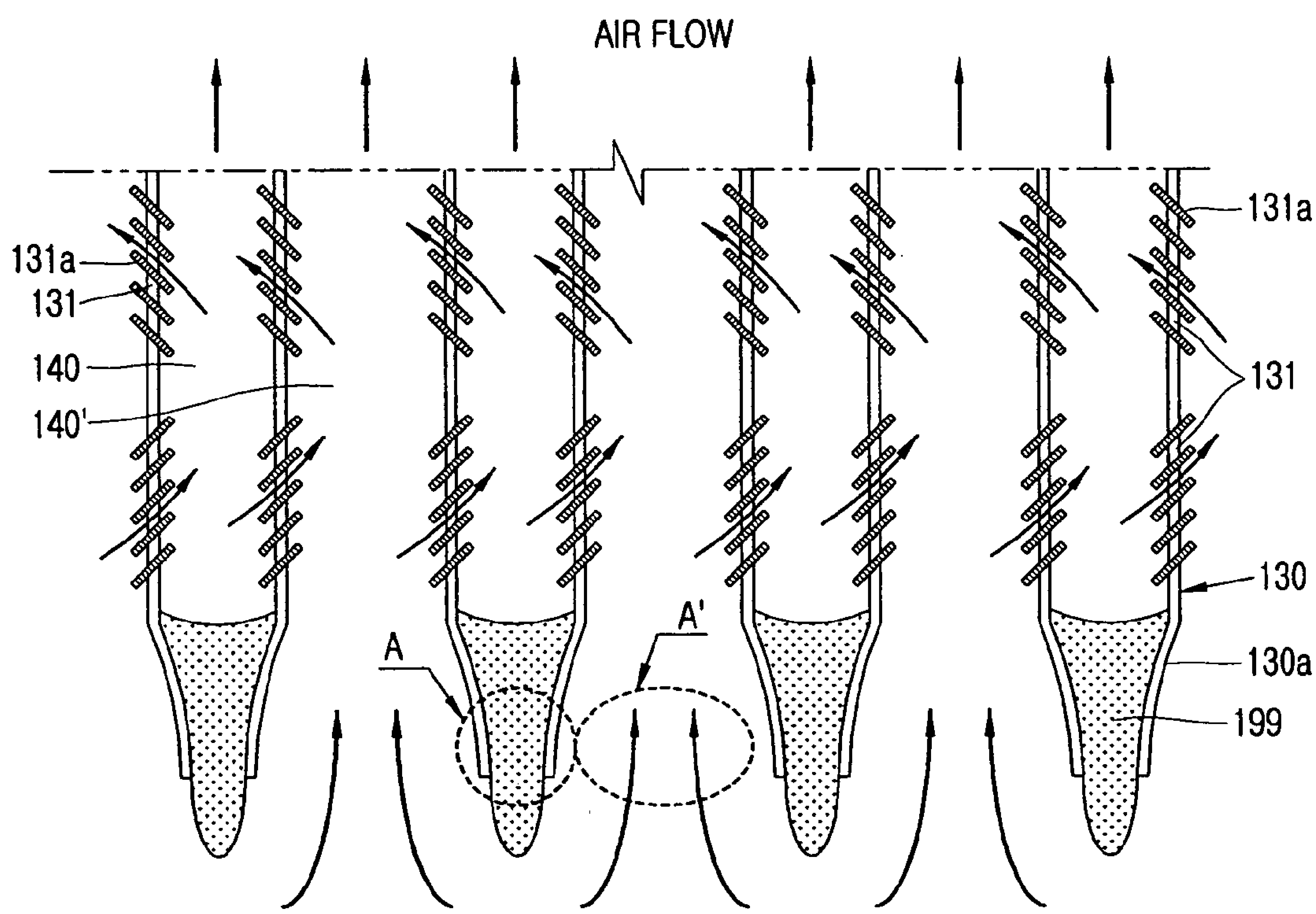

AIR FLOW
131a
131
140
140'
130
130a
199
A
A'

FIG. 7

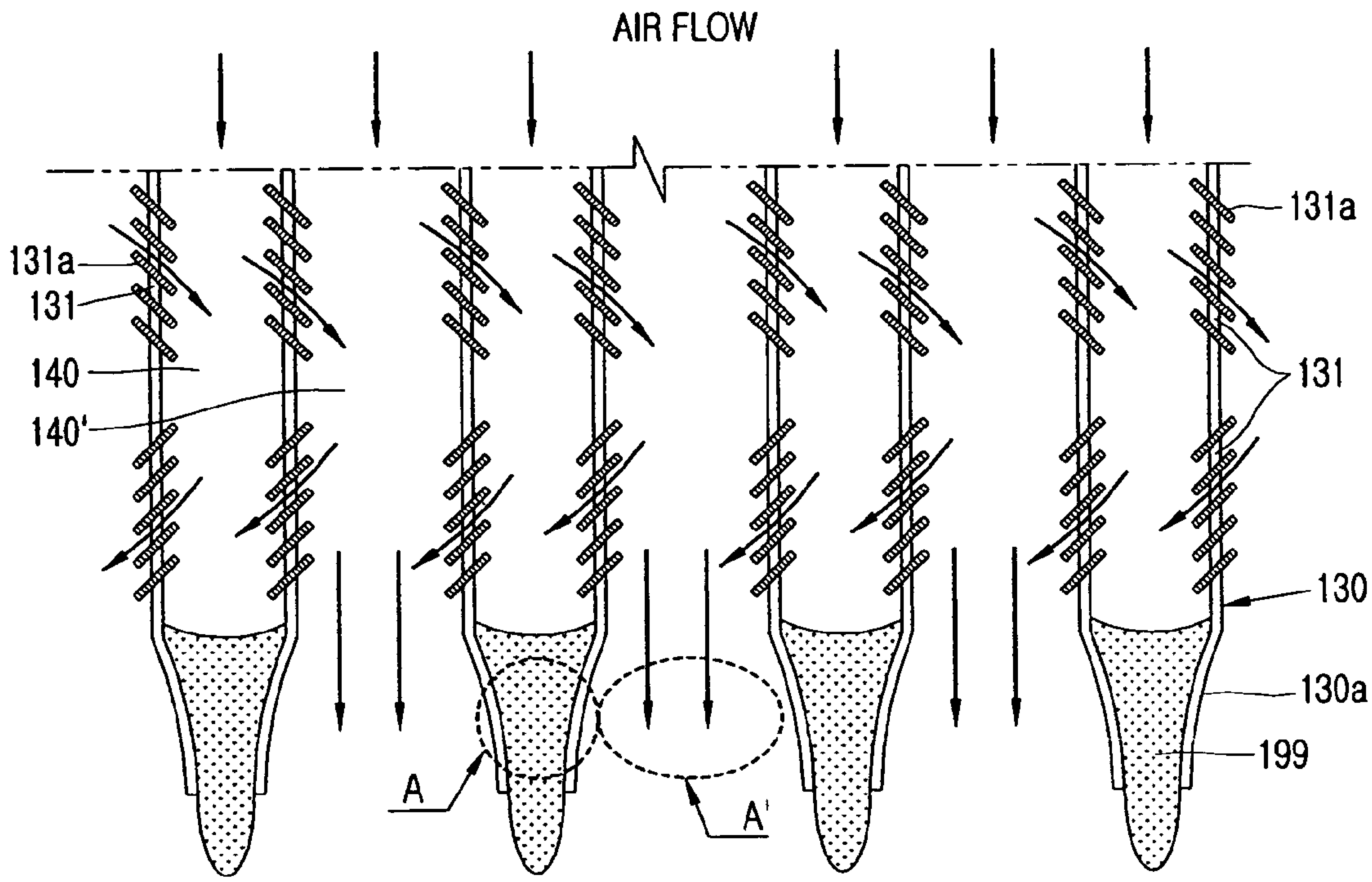

AIR FLOW
131a
131a
131
140
140'
131
130
130a
199
A
A'

FIG. 8

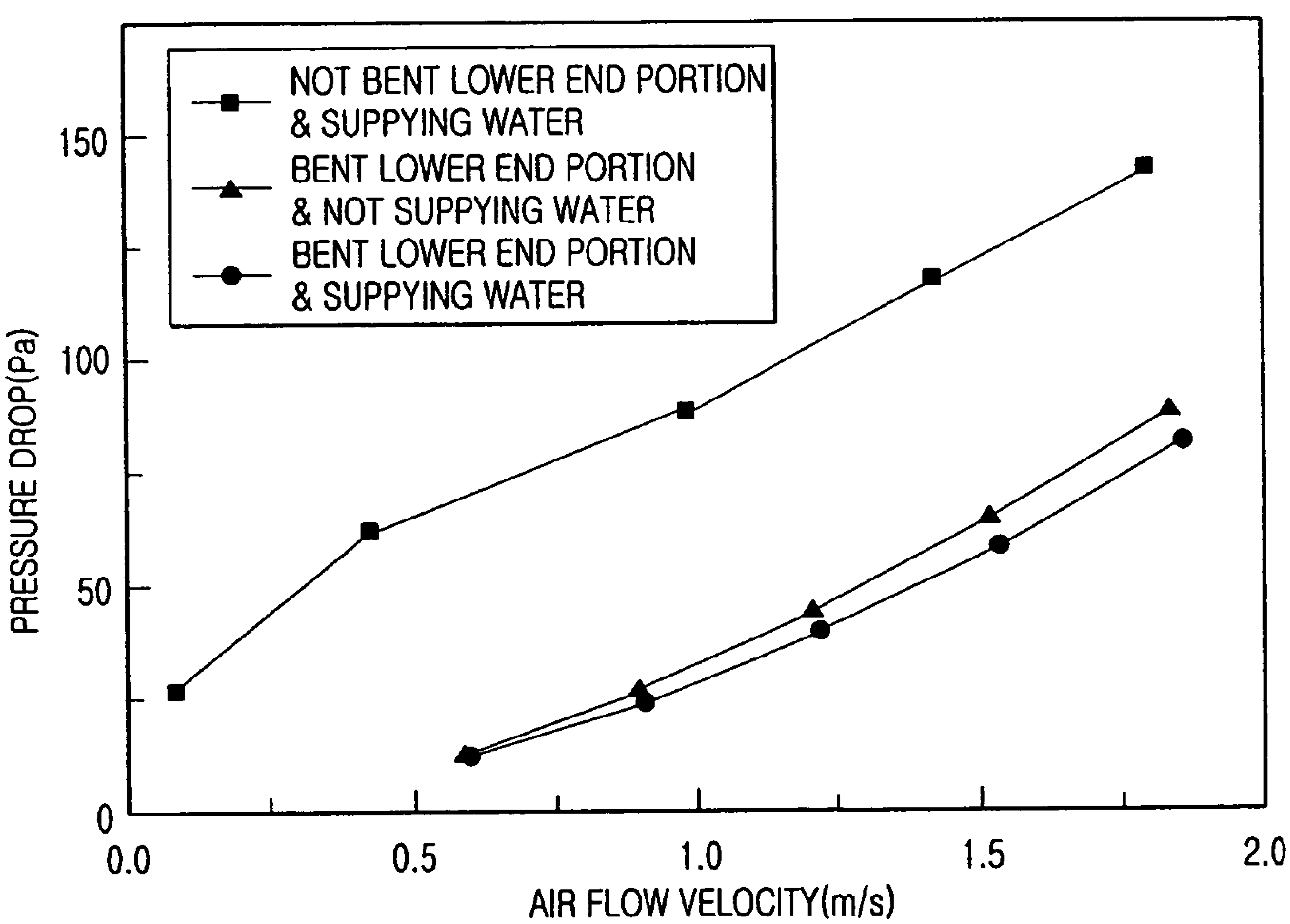

NOT BENT LOWER END PORTION
& SUPPYING WATER
BENT LOWER END PORTION
& NOT SUPPYING WATER
BENT LOWER END PORTION
& SUPPYING WATER
PRESSURE DROP(Pa)
150
100
50
0
0.0
0.5
1.0
1.5
2.0
AIR FLOW VELOCITY(m/s)

FIG. 9

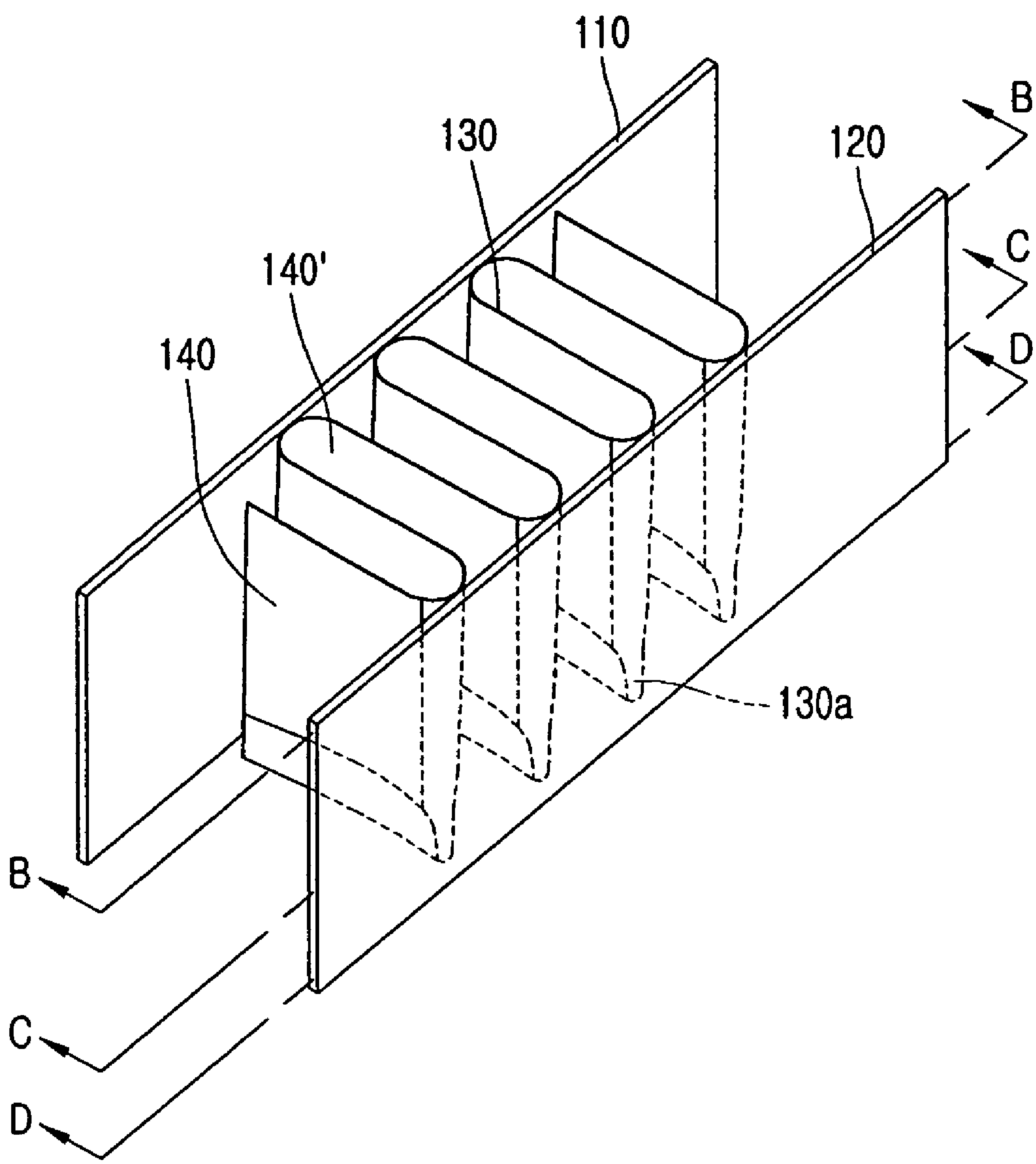


FIG. 10A

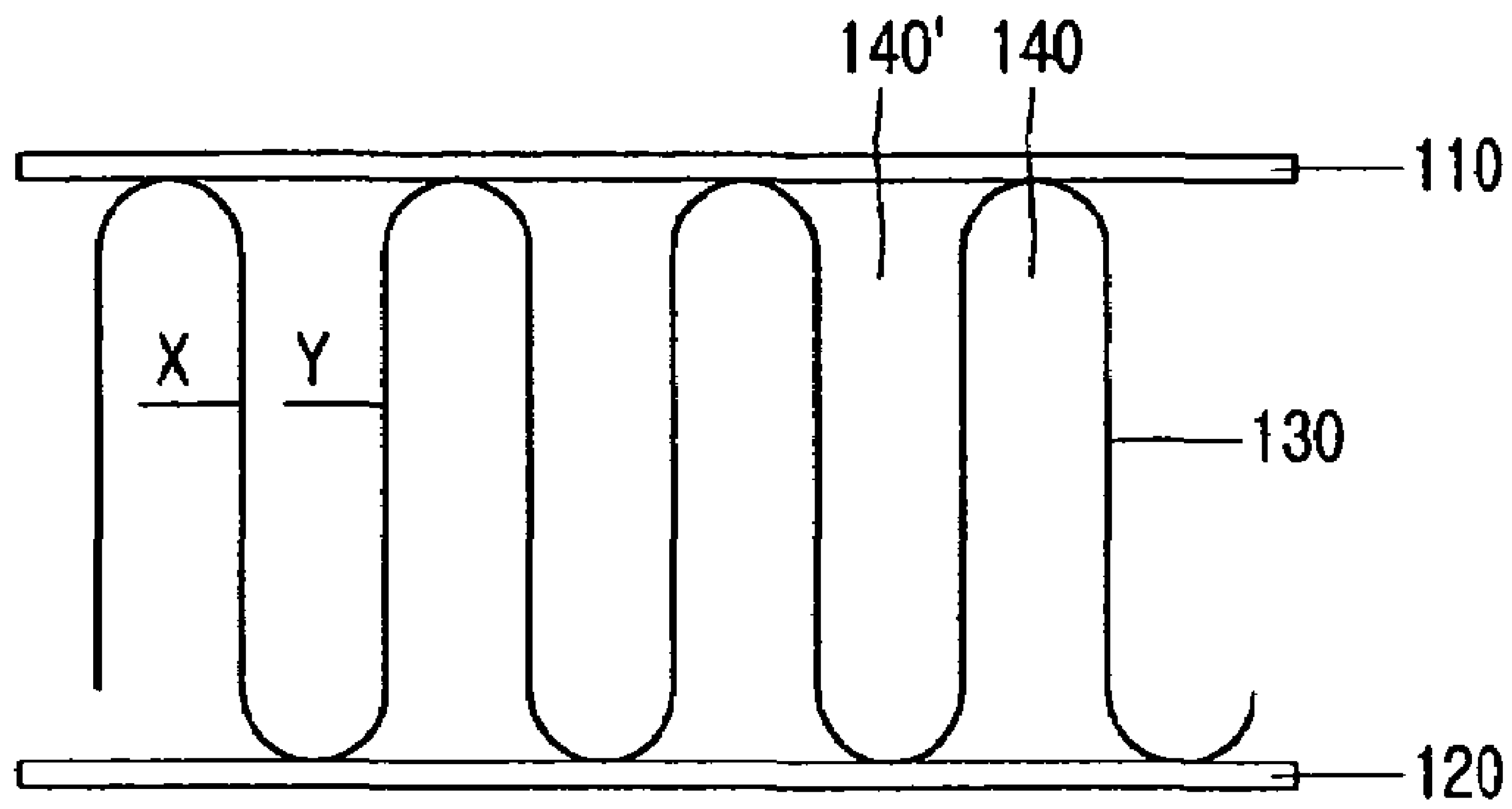


FIG. 10B

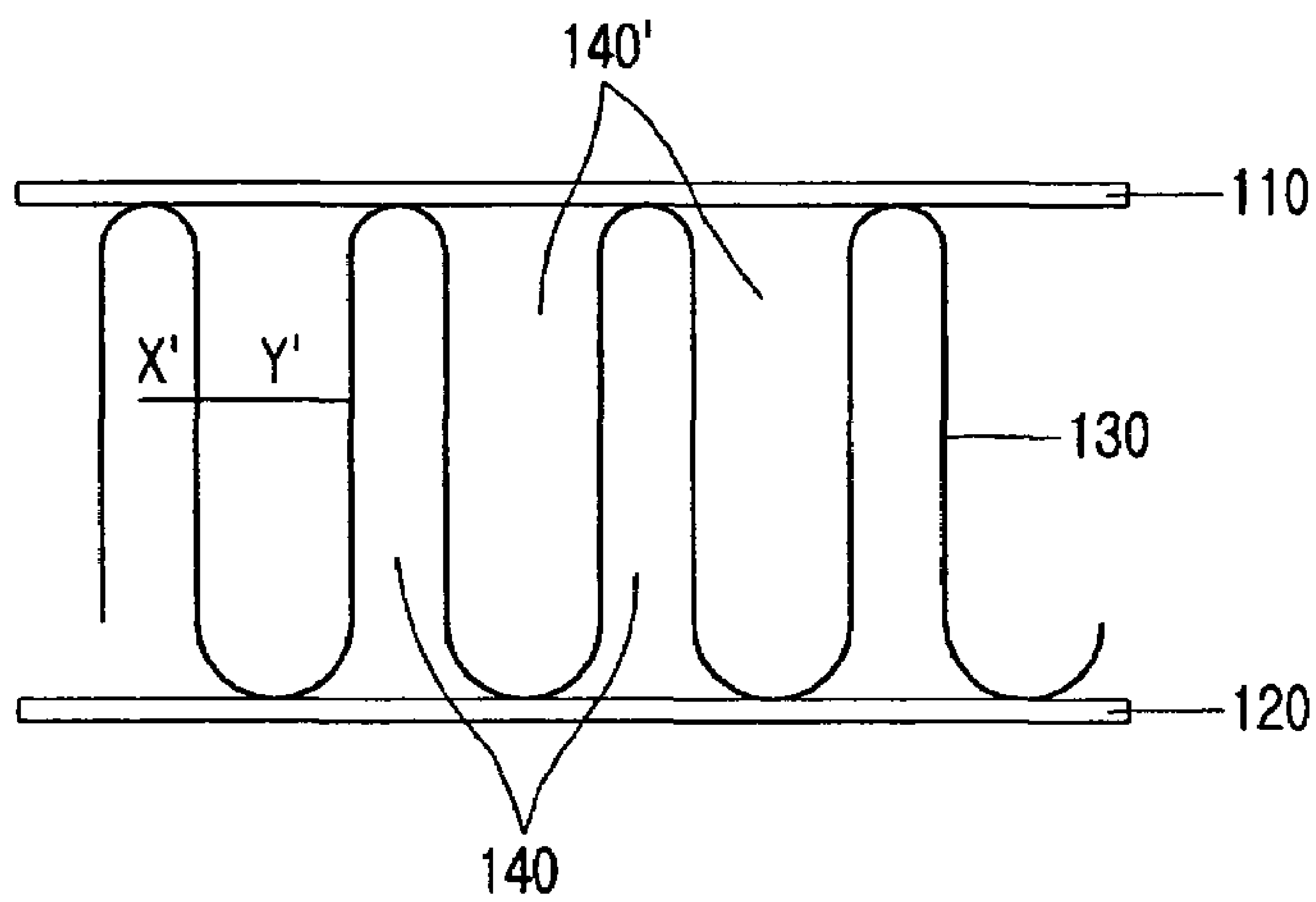


FIG. 10C

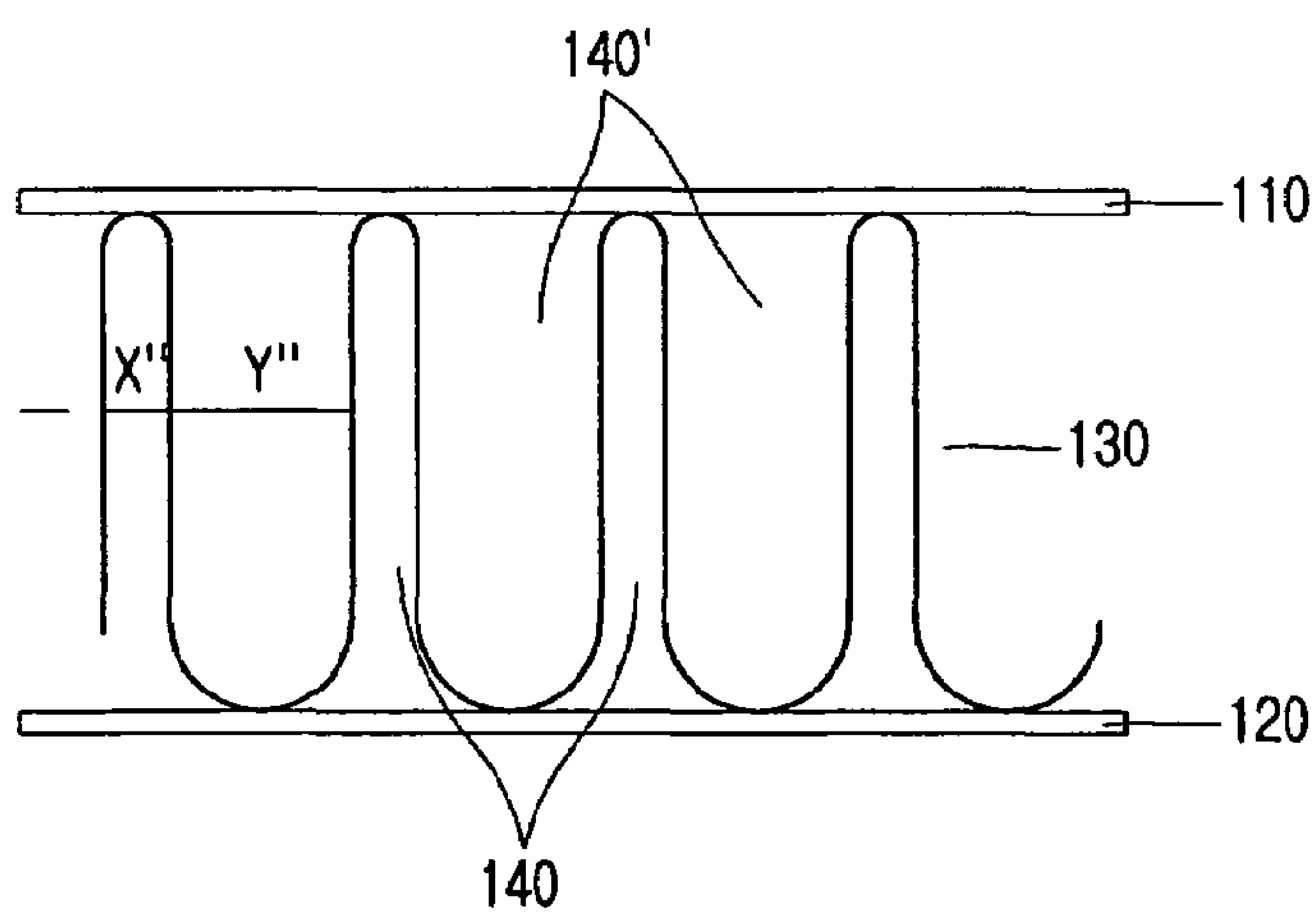


FIG. 11

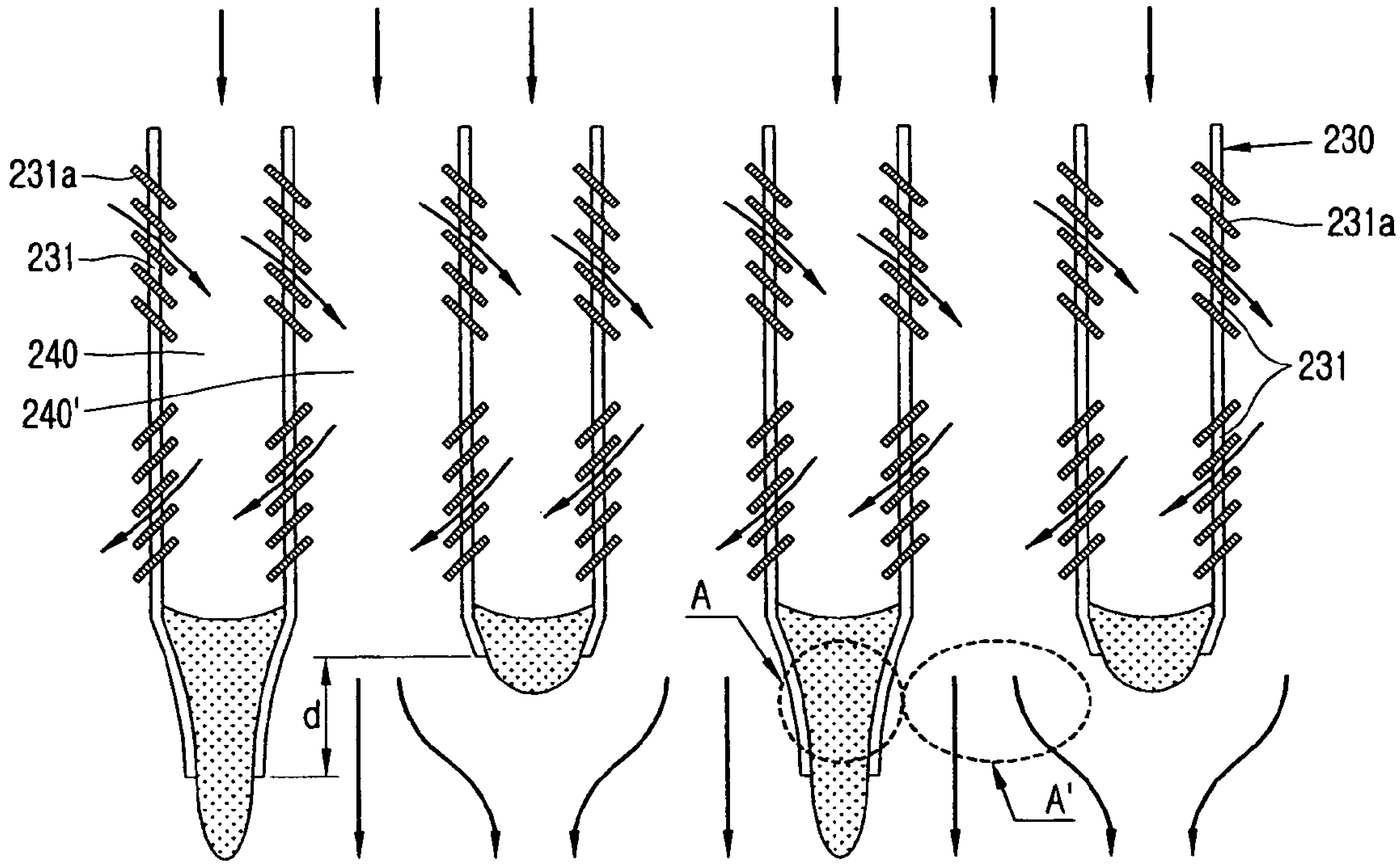
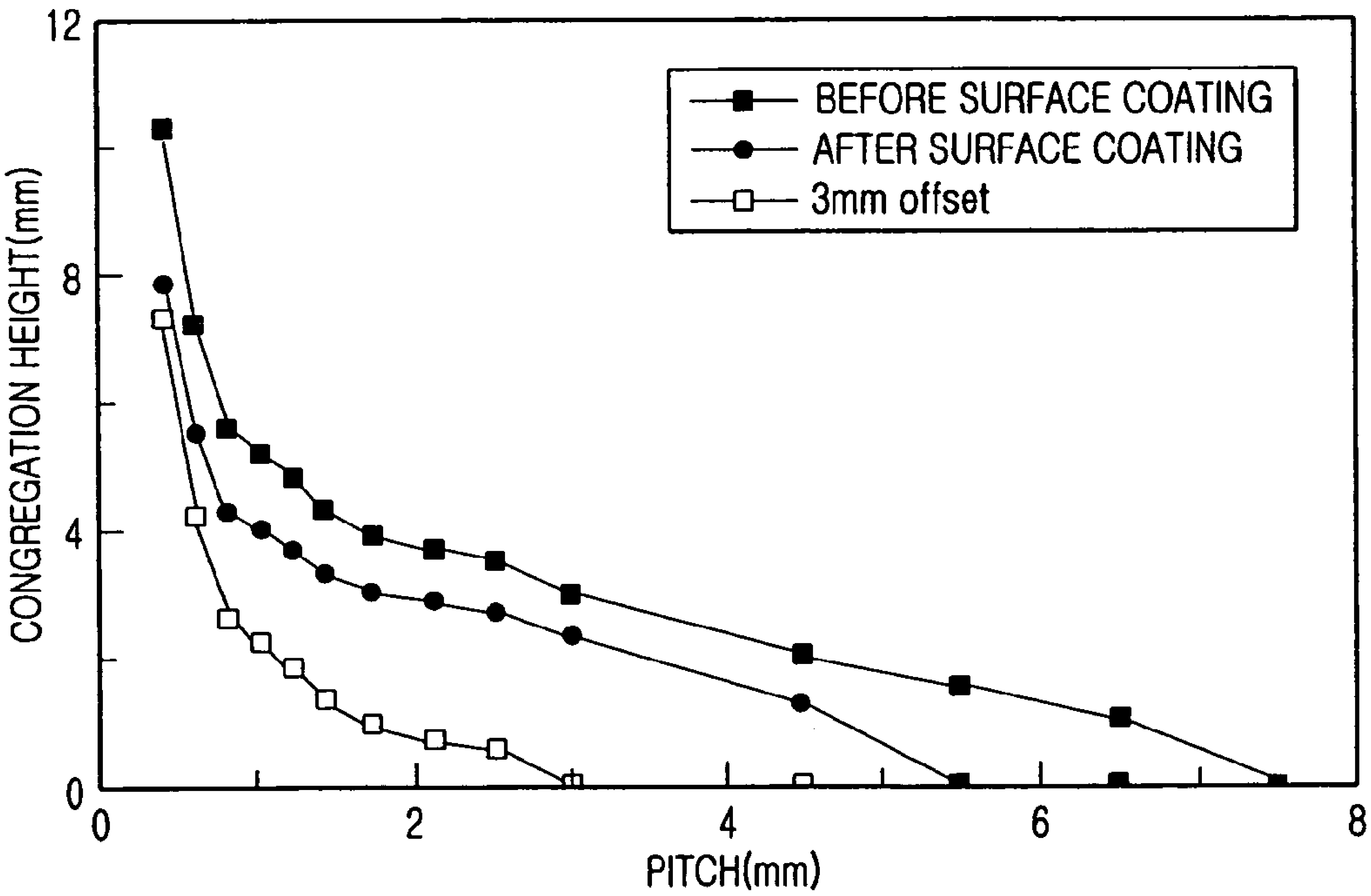

230
231a
231
240
240'
231a
231
A
d
A'

FIG. 12


BEFORE SURFACE COATING
AFTER SURFACE COATING
3mm offset
CONGREGATION HEIGHT(mm)
PITCH(mm)
0
2
4
6
8
0
4
8
12

LOUVER FIN TYPE HEAT EXCHANGER HAVING IMPROVED HEAT EXCHANGE EFFICIENCY BY CONTROLLING WATER BLOCKAGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a louver fin type heat exchanger, and particularly, to a louver fin type heat exchanger having high reliability and improved efficiency by securely obtaining the air passageway in the heat exchanger, by minimizing a pressure drop of the air flow, and by controlling congregating of water drops formed by condensation (i.e., water blockage) at lower end portions of air passages of the louver fin type heat exchanger positioned upright at a certain angle with respect to the ground.

2. Description of the Background Art

In general, heat exchange between fluids is essential in a number of processes of heat-related industry. Therefore, various types of heat exchangers having improved efficiency in a heating system through effective heat exchange are being used. Of the heat exchangers, a heat exchanger used for a home air conditioner, an engine coolant system of a car, an air conditioning system of a car or the like, has fins securing a wider heat transfer area in order for the heat exchange with the external air.

Recently, the use of a compact heat exchanger having fins having a heat transfer area of about 100 m^2/m^3 or more is started according to demands for a leaner and lighter heat exchanger. The compact heat exchanger is divided into a plate-fin heat exchanger and a fin-tube heat exchanger. As the compact heat exchanger used in an air conditioning system, the fin-tube type heat exchanger was generally used. However, because the fin-tube type heat exchanger is problematic in that its weight is increased due to a copper pipe provide thereto and recycling of a material is difficult because materials of a fin and a tube are different, the fin-tube type heat exchanger is being replaced with the plate-fin type heat exchanger in the field of a package air conditioner and an air conditioning system for a car, which require to be leaner and lighter.

As shown in FIG. **1** to **3**, a louver fin type heat exchanger **1**, which is one of plate-fin type heat exchangers whose usable range is gradually increasing, includes two or more plates **10** and **20** formed of a metallic material and spaced apart from each other at a predetermined interval, a louver fin unit **30** coupled with the plates **10** and **20** and having at least one louver fin, and an air passage **40** formed between the plates **10** and **20** and the louver fin unit **30** for the purpose of allowing heat exchange between external air and the louver fin **30** or the like.

As shown in FIGS. **2** and **3**, the louver fin **30** includes a plurality of louvers **31***a* bent at a predetermined angle to induce an air flow, and a plurality of through holes **31** between the louvers **31***a* to communicate with the air passages **40**, thereby contributing to effective heat exchange between the air introduced from the outside and the louver fin **30**.

Although FIG. **1** shows the louver fin type heat exchanger **1** in which one louver fin unit **30** is coupled between two plates **10** and **20**, substantially, the plate-fin type heat exchanger to which the louver fin unit **30** is applied is constructed such that louver fins **30** are respectively bonded between a few plates **10**, **20** or between several tens of plates **10**, **20**.

By such a construction, the air introduced from the outside in a first air-flow direction or a second air-flow direction passes between the plates **10**, **20** and the louver fin unit **30**, exchanging heat with the plates **10** and **20** and the louver fin unit **30**. In such a manner, the heat of the plates **10** and **20** and the louver fin **30** is released to the outside or introduced thereinto.

However, if the louver fin type heat exchanger **1** (not shown) is positioned upright at a predetermined angle with respect to the ground and is simultaneously used as a freezer evaporator or the like, the air introduced into the heat exchanger is condensed while passing through the cool air passages **40** and moisture **90** flows down toward the ground by gravity. Thus, as shown in FIG. **4**, moisture **99** irregularly congregates (i.e., water blockage occurs) on lower end portions of the louver fin unit **30** close to the ground. Here, because the moisture congregating on the lower end portions of the louver fin **30** blocks the air passage **40**, the introduction to the air passage **40** or outflow of the air from the air passage **40** is not smoothly made, which causes an increase in a pressure drop of the air passing through the heat exchanger **1** and accordingly deteriorates heat exchange efficiency of the heat exchanger **1**.

Furthermore, even though the heat exchanger is not used for the freezer evaporator in which the external air should pass through the cool air passage, the aforementioned problem may occur even when the louver fin type heat exchanger positioned upright at a predetermined angle with respect to the ground is used for a freezer condenser, a radiator, an oil cooler or the like and evaporation water is sprayed or dropped to improve cooling performance by an evaporation cooling effect. For this reason, a need to solve such problems is increasing.

In order to solve such problems, there was an attempt to reduce congregating moisture (i.e., water blockage) by reducing a contact angle between water and a fin by hydrophilic surface coating on a surface of the fin. Thus, as shown in FIG. **5**, the extent to which the moisture congregates at the lower end portions of the louver fin **30** can be reduced as compared to the case where the hydrophilic surface coating is not performed. However, when a gap between the plates is 5 mm or less, the water blockage still occurs.

Particularly, from the view on the tendency that the gap is getting smaller in response to the demand for a smaller heat exchange, it can be known through the experiment of FIG. **5** that there is a limit in improving performance of the louver fin type heat exchanger only by hydrophilic coating.

As another solution for the congregating moisture of the louver fin type heat exchanger, research is conducted on reducing a contact angle between a fin and moisture by fabricating a porous fin with fine metal powder. However, this method is also problematic in that the moisture still congregates when pitches between fins are 5 mm or less.

BRIEF DESCRIPTION OF THE INVENTION

Therefore, an object of the present invention is to provide a louver fin type heat exchanger having high reliability and improved heat-exchange efficiency by stably securing a smooth air flow within the louver fin type heat exchanger by controlling water blockage at lower end portions of the louver fin type heat exchanger at a predetermined angle with respect to the ground.

Another object of the present invention is to provide a louver fin type heat exchanger which can effectively applied to a freezer evaporator, a condenser using an evaporator cooling effect, a radiator or the like even when intervals between fins are small due to small pitches of the heat exchanger, by preventing a phenomenon where a pressure loss of the air is increased because flow resistance of the air passing through the louver fin type heat exchanger is increased by the water blockage occurring at the lower end portions of the louver fin unit and where performance of the heat exchanger is deteriorated because the flow of the air passing through the louver fin type heat exchanger is decreased.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a louver fin type heat exchanger comprising two or more plates respectively spaced apart from each other and positioned upright at a certain angle with respect to the ground, and a louver fin unit with a wave-pattern cross-section inserted between the plates, whereby an air passage is formed in the spaces between the plates and each louver fin of the louver fin unit, the heat exchanger characterized in that the louver fin unit having at least one louver fin with a lower end portion close to the ground being formed to be bent towards an adjacent louver, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at the other portions thereof.

Thusly, the air passages at a side close to the ground which are formed by being surrounded by the plates and the louver fins have different cross-section areas, such that moisture congregates only at the air passage with a small cross-section area and does not congregate at the air passage with a large cross-section area. Accordingly, minimizing the pressure drop, the external air smoothly passes into or out the heat exchanger through the air passage where the moisture does not congregate, thereby improving heat exchange efficiency of the louver fin heat exchanger.

A plurality of through holes are formed on the louver fins, and the air introduced into the heat exchanger through the through hole is uniformly spread to an adjacent air passage where an air flow is not active due to the moisture congregating at a lower end portion, thereby obtaining high efficiency in heat exchange.

Here, the lower end portions of the louver fins close to the ground are bent toward the lower end portions of adjacent louver fins to be closer together or further apart in an alternating manner, such that the cross-section areas of the lower end portions of the air passage close to the ground are alternatingly narrower and wider. Thusly, the pressure drop of the air passing into or out the heat exchanger can be minimized.

If intervals between louver fins are smaller to minimize the heat exchanger, moisture may congregate even at lower end portions of the louver fins with wider cross-section areas. Therefore, the lower end portions of the louver fins close to the ground is formed to be longer than the lower end portions of other louver fins so as to have an offset (d). In such a manner, the moisture can be prevented from congregating at the lower end portions of the louver fins having the wider cross-section areas.

Here, the lengths of the lower end portions of the louver fins close to the ground are longer than or shorter than the lengths of the lower end portions of adjacent louver fins, such that the lengths of the air passages of the lower end portions close to the ground are alternatingly longer and shorter.

Effectively, an offset (d) between the long lower end portion and the short lower end portion of the louver fins is 3 mm or greater.

Thusly, although moisture congregates at the lower end portions of the louver fins, the air can flow between positions where the water congregates, so that a pressure loss of the air passing through the louver fin type heat exchanger can be minimized.

The present invention is proposed on the assumption that moisture congregating within the heat exchanger or spreading from the outside moves toward a portion close to the ground by the gravity. Accordingly, the present invention can obtain the greatest effect when the louver fin type heat exchanger is positioned upright at an angle, which is almost perpendicular to the ground, for example, 75°~90°.

Hydrophilic surface coating may be performed on a surface of one of the plates and the louver fin unit in order to reduce a contact angle with the moisture. Also, preferably, the plates and the louver fin unit are made of an aluminum material having high heat conductivity.

According to the present invention, even a compact louver fin type heat exchanger in which a gap of the plates or intervals between the louver fins are 0.5 mm~5 mm which is small, can secure improved efficiency of the heat exchange because the pressure drop of the air passing through the heat exchanger can be minimized.

Herein, the lower end portions of the louver fins close to the ground are bent towards the lower end portions of adjacent louver fins to be closer together or further apart in an alternating manner, such that the cross-section areas of the lower end portions of the air passage close to ground are alternatingly narrower and wider.

A plurality of flow passages are formed between the louvers on the louver fins so as to allow the air to flow between the finned channels.

Herein, the lower end portions close to the ground of a part of louver fins are longer than those of the other louver fins. Further, the lower end portions close to the ground of a part of the louver fins are longer than or shorter than those of adjacent louver fins, such that the lengths of the air passages of the lower end portions close to the ground are alternatingly longer and shorter.

Also, the plates are positioned upright at an angle of 75°~90° with respect to the ground. And the gap between the fins is 0.5 mm~5 mm, and the plates and the louver fins are made of an aluminum material.

The hydrophilic surface coating is performed on at least one of the plates and the louver fin unit.

The louver fin type heat exchanger further comprises two or more plates respectively spaced apart from each other and positioned upright at a certain angle with respect to the ground, and a louver fin unit with a wave-pattern cross-section inserted between the plates, whereby an air passage is formed in the spaces between the plates and each louver fin of the louver fin unit, the heat exchanger characterized in that the lower end portions close to the ground of a part of louver fins are longer than those of the other louver fins.

Herein, the lower end portions close to the ground of the louver fins are longer than or shorter than the those of adjacent louver fins, such that the lower end portions close to the ground are alternatingly longer and shorter. And, the length difference between the louver fins is 3 mm or greater.

Also, a plurality of flow passages are formed between the louvers on the louver fins so as to allow the air to flow between the finned channels.

The lower end portions of the louver fins close to the ground are bent toward the lower end portions of adjacent louver fins, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at other portions thereof.

The lower end portions of the louver fins close to the ground can be bent toward the lower end portions of adjacent louver fins to be closer together or further apart in an alternating manner, such that the cross-section areas of the lower end portions of the air passage close to the ground are alternatingly narrower and wider.

Herein, the plates are positioned upright at an angle of 75°~90° with respect to the ground. And, the hydrophilic surface coating is performed on at least one of the plates or the louver fin unit, an interval between the fins is 0.5 mm~5 mm.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a unit of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** is a partial perspective view which illustrates a structure of a louver fin type heat exchanger in which an air flow is made in a vertical direction;

FIG. **2** is an enlarged perspective view which illustrates a shape of a louver fin of FIG. **1**;

FIG. **3** is a sectional view taken along line III-III of FIG. **1**;

FIG. **4** is a schematic view which illustrates a sectional shape of the conventional louver fin in which an air passage is blocked by moisture congregating at lower end portions of the louver fin;

FIG. **5** is a graph which illustrates an experimental result of measuring a height of congregating moisture according to a pitch before and after performing a hydrophilic surface treatment on the louver fin of FIG. **1**;

FIGS. **6** to **10**C are views which illustrate a louver fin type heat exchanger in accordance with one embodiment of the present invention,

wherein FIGS. **6** and **7** are schematic views which illustrate a sectional shape of the louver fin taken along line A-A of FIG. **1**,

FIG. **8** is a graph which illustrates an experimental result of measuring a pressure drop according to the shape of the louver fin of FIG. **6**,

FIG. **9** is a perspective view of FIG. **6**,

FIG. **10**A is a sectional view of the louver fin taken along line B-B of FIG. **9**,

FIG. **10**B is a sectional view of the louver fin taken along line C-C of FIG. **9**, and

FIG. **10**C is a sectional view of the louver fin taken along line D-D of FIG. **9**; and

FIGS. **11** and **12** are views which illustrate the louver fin type heat exchanger in accordance with another embodiment of the present invention, wherein FIG. **11** is a schematic view which illustrates a sectional shape of the louver fin taken along line A-A of FIG. **1**, and FIG. **12** is data of an experiment on measuring a height of congregating moisture according to the shape of the louver fin of FIG. **11**.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIGS. **6** to **10**C are views which illustrate a louver fin type heat exchanger in accordance with one embodiment of the present invention, wherein FIGS. **6** and **7** are schematic views which illustrate a sectional shape of the louver fin taken along line A-A of FIG. **1**, FIG. **8** is a graph which illustrates an experimental result of measuring a pressure drop according to the shape of the louver fin of FIG. **6**, FIG. **9** is a perspective view of FIG. **6**, FIG. **10**A is a sectional view of the louver fin taken along line B-B of FIG. **9**, FIG. **10**B is a sectional view of the louver fin taken along line C-C of FIG. **9**, and FIG. **10**C is a sectional view of the louver fin taken along line D-D of FIG. **9**.

As shown in FIGS. **6** and **7**, the louver fin type heat exchanger **100** in accordance with one embodiment of the present invention includes two or more plates **110** and **120** positioned upright vertically with respect to the ground and spaced apart from each other at an interval of about 3 mm, a louver fin unit **130** coupled with the plates **110** and **120** therebetween and having at least one louver fin, and air passages **140** and **140'** surrounded by the plates **110** and **120** and the louver fin unit **130**, in which heat exchange between the louver fin unit **130** and external air flowing in an out from the passages occurs.

Each plate **110**, **120** is made of an aluminum material having good heat conductivity. Although only a pair of plates are shown in FIGS. **6** and **7**, more plates, for example, tens of plates are commonly used.

The louver fin unit **130** is formed of an aluminum material having good heat conductivity and has a wave pattern. A plurality of louvers **131***a* are formed on a surface of the louver fin unit **130**, and through holes **131** formed between the louvers **131** communicate with adjacent air passages **140**, **140'**, so that efficient heat exchange can occur between the air introduced from the outside and the louver fin unit **130**. Here, the wave pattern of the louver fin unit **130** may be formed to have various-sized pitches, but in general, the pitches (x, y) of the louver fin unit **130** are about three times to eight times greater than the interval between the plates **110** and **120**.

Here, lower end portions **130***a* of the louver fin unit **130** close to the ground are formed to be bent toward each other in an alternating manner. Namely, as shown in FIG. **10**A, pitches (x, y) of the louver fin unit **130** is constant at upper end portions of the louver fin unit **130** which are not bent. However, as shown in FIGS. **10**B and **10**C, the bent portions of the lower end portions of the louver fin unit **130** are formed such that pitches (x', y', x", y") of the louver fin unit **130** are alternatingly narrower and wider. Accordingly, the cross-section areas of the air passages **140**, **140'** close to the ground are alternatingly narrower or wider. Thus, when the louver fin type heat exchanger **100** is positioned upright, inclined with respect to the ground, moisture flowing down along the air passages **140**, **140'** is introduced to and congregates at end portions (A) having a narrower cross-section area, and moisture **199** does not congregate at end portions (A') of the louver fin **130** having a relatively wider cross-section area.

Accordingly, as shown in FIG. **6**, when the air performs heat exchange while passing upwardly from the ground through the heat exchanger **100** and moisture **199** flows down in the gravity direction, the moisture congregates to a certain height only at the narrower end portions (A) of the louver fin **130**. For this reason, the external air is smoothly introduced into the air passage **140'** through the wider end portions of the louver fin **130**, and the air introduced from the outside is dispersed to an adjacent air passage **140** through the through hole **131** of the louver fin **130**, so that the heat exchange occurs in an entire louver fin type heat exchanger **100**. Namely, although the moisture congregates at the end portions of the louver fin **130**, a pressure drop of the air passing through the heat exchanger **100** may be minimized, thereby implementing efficient heat exchange.

Likewise, as shown in FIG. **7**, if the air penetrates the heat exchanger **100** downwardly from an upper side toward the ground, the air uniformly introduced through the air passages **140**, **140'** having the uniform cross-section areas flows to adjacent air passages **140**, **140'** through the through holes **131** of the louver fin unit **130** while passing the air passage of the louver fin type heat exchanger **100**, thereby exchanging heat with the louver fin type heat exchanger **100**. Here, when the moisture **199** condensed or applied flows down to the lower end portions of the louver fin unit **130** in the direction of gravity, the moisture congregates to a certain height only at the narrower end portions (A) of the louver fin unit **130**. Thus, the air within the heat exchanger **100** is smoothly discharged to the outside through the wider end portions (A') of the louver fin unit **130**. Accordingly, a pressure drop of the air passing through the heat exchanger **100** is minimized and efficient heat exchange can be implemented.

FIG. **8** is a graph which illustrates a result of measuring the amount of pressure drop of the air according to a shape of the conventional louver fin and a shape of the louver fin of FIG. **6**. By the experimental result of FIG. **8**, it can be known that, if the lower end portions of the louver fin **130** are formed to be bent, the amount of a pressure drop of the air can be greatly reduced as compared to by the shape of the conventional louver fin shape.

The louver fin type heat exchanger **200** in accordance with another embodiment of the present invention will now be described.

Only, in describing another embodiment of the present invention, the same or similar reference numerals are designated to the same or similar structures and parts as those of the aforementioned one embodiment, and the detailed description thereon will be omitted.

As shown in FIG. **11**, the louver fin type heat exchanger **200** is different from the louver fin type heat exchanger **100** in that lower end portions **230***a* of the louver fin unit **230** close to the ground are alternatingly and thusly have an offset of 'd' shown in the drawing with respect to adjacent lower end portions **230***a* of the louver fin unit **230**.

In the louver fin type heat exchanger **200** constructed in the aforementioned manner, pitches of the fin unit are small. For this reason, although moisture congregates at end portions (A') of the louver fin unit **130** formed to have the wider cross-section area as in one embodiment **100**, such water blockage that interrupts the passage of the air into the heat exchanger can be prevented. Namely, as shown in FIG. **11**, moisture flowing down through the air passages **240**, **240'** congregates at narrower end portions of the louver fin unit **230**. Here, because of an offset (d) between the wider lower end portion (A') of the louver fin unit **230** and the narrower lower end portion (A) of the louver fin unit **230**, a distance between the end portions (A and A') of the louver fin unit is longer than a separation distance which might cause moisture to congregate (water blockage) **299**, **299'**. Thusly, the moisture congregates only at the narrower lower end portions (A) of the louver fin unit **230** and does not congregate at the wider lower end portions (A') of the louver fin unit **230**, so that external air can pass the air passage **240'** through the wider lower end portions (A') of the louver fin unit **230**.

Such a louver fin unit **230** is manufactured by alternately cutting the lower end portions of the louver fin **130** in accordance with one embodiment.

FIG. **12** is a graph which illustrates an experimental result of measuring the height of congregating moisture according to the case where the lengths of the lower end portions of the louver fin unit **130** are formed to be different. As shown in FIG. **12**, if the bent portions of the louver fin unit **230** are cut to have an offset of about 3 mm as compared to adjacent bent portions **230**, the height of the moisture congregating at the lower end portions of the louver fin unit **230** can be greatly reduced as compared to the case where only the hydrophilic surface coating is performed on the louver fin **230**. Accordingly, as the lengths of the lower end portions of the louver fin unit **130** are different in an alternating manner, the moisture is prevented from congregating even when the fin unit have extremely small pitches of 1.5 m or less, and a pressure drop of the air can be minimized.

Also, although not shown in FIG. **12**, if the louver fin unit **230** has very small pitches of 1.5 mm, the lower end portions **230***a* of the louver fin unit **230** are formed to have an offset (d) of about 3 mm to 12 mm. Then, the pressure drop of the air occurring due to the congregation moisture (water blockage) can be greatly restricted.

As described so far, in the louver fin type heat exchanger positioned upright at a certain angle with respect to the ground, lower end portions of the louver fin unit close to the ground are bent toward adjacent lower end portions of the louver fin unit, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at other portions thereof. Accordingly, moisture congregates (i.e., water blockage occurs) only at the air passage with a small cross-section area and does not congregate at the air passage with a large cross-section area. Thusly, minimizing a pressure drop, the external air smoothly passes into the heat exchanger through the air passages where the moisture does not congregate (i.e., the water blockage does not occur), so that the louver fin type heat exchanger has the improved heat exchange efficiency.

Also, according to the present invention, even in a compact louver fin type heat exchanger having a fin unit with small pitches of 0.5 mm to 5 mm, lower end portions of the louver fin unit close to the ground are formed to have an offset longer than that of other lower end portions thereof. Accordingly, the moisture congregates only at the air passage having a small cross-section area and does not occur at the air passage having a large cross-section area, so that the amount of a pressure drop of the air passing through the heat exchanger is minimized and the improved heat exchange efficiency is secured.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A louver fin type heat exchanger comprising two or more plates respectively spaced apart from each other and positioned upright at a certain angle with respect to the ground, and a louver fin unit with a wave-pattern cross-section inserted between the plates, whereby an air passage is formed in the spaces between the plates and each louver fin of the louver fin unit, the heat exchanger characterized in that:

the louver fin unit having at least one louver fin with a lower end portion close to the ground being formed to be bent towards an adjacent louver, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at the other portions thereof.

2. The heat exchanger of claim **1**, wherein the lower end portions of the louver fins close to the ground are bent towards the lower end portions of adjacent louver fins to be closer together or further apart in an alternating manner, such that the cross-section areas of the lower end portions of the air passage close to ground are alternatingly narrower and wider.

3. The heat exchanger of claim **2**, wherein a plurality of flow passages are formed between the louvers on the louver fins so as to allow the air to flow between the finned channels.

4. The heat exchanger of claim **2**, wherein the lower end portions close to the ground of a part of louver fins are longer than those of the other louver fins.

5. The heat exchanger of claim **4**, wherein the lower end portions close to the ground of a part of the louver fins are longer than or shorter than those of adjacent louver fins, such that the lengths of the air passages of the lower end portions close to the ground are alternatingly longer and shorter.

6. The louver fin type heat exchanger of claim **1**, wherein the plates are positioned upright at an angle of 75°~90° with respect to the ground.

7. The louver fin type heat exchanger of claim **1**, wherein hydrophilic surface coating is performed on at least one of the plates and the louver fin unit.

8. The louver fin type heat exchanger of claim **1**, wherein a gap between the fins is 0.5 mm~5 mm.

9. The louver fin type heat exchanger of claim **1**, wherein the plates and the louver fins are made of an aluminum material.

10. The heat exchanger of claim **1**, wherein the plates and the louver fin unit are formed of an aluminum material.

11. A louver fin type heat exchanger comprising two or more plates respectively spaced apart from each other and positioned upright at a certain angle with respect to the ground, and a louver fin unit with a wave-pattern cross-section inserted between the plates, whereby an air passage is formed in the spaces between the plates and each louver fin of the louver fin unit, the heat exchanger characterized in that:

the lower end portions close to the ground of a part of louver fins are longer than those of the other louver fins.

12. The heat exchanger of claim **11**, wherein the lower end portions close to the ground of the louver fins are longer than or shorter than the those of adjacent louver fins, such that the lower end portions close to the ground are alternatingly longer and shorter.

13. The heat exchanger of claim **12**, wherein the length difference between the louver fins is 3 mm or greater.

14. The heat exchanger of claim **13**, wherein a plurality of flow passages are formed between the louvers on the louver fins so as to allow the air to flow between the finned channels.

15. The heat exchanger of claim **12**, wherein the lower end portions of the louver fins close to the ground are bent toward the lower end portions of adjacent louver fins, such that the air passage at the lower end portion close to the ground has cross-section areas that are wide at certain portions and are narrow at other portions thereof.

16. The heat exchanger of claim **15**, wherein the lower end portions of the louver fins close to the ground are bent toward the lower end portions of adjacent louver fins to be closer together or further apart in an alternating manner, such that the cross-section areas of the lower end portions of the air passage close to the ground are alternatingly narrower and wider.

17. The heat exchanger of claim **11**, wherein the plates are positioned upright at an angle of 75°~90° with respect to the ground.

18. The heat exchanger of claim **11**, wherein hydrophilic surface coating is performed on at least one of the plates or the louver fin unit.

19. The heat exchanger of claim **11**, wherein an interval between the fins is 0.5 mm~5 mm.

* * * * *